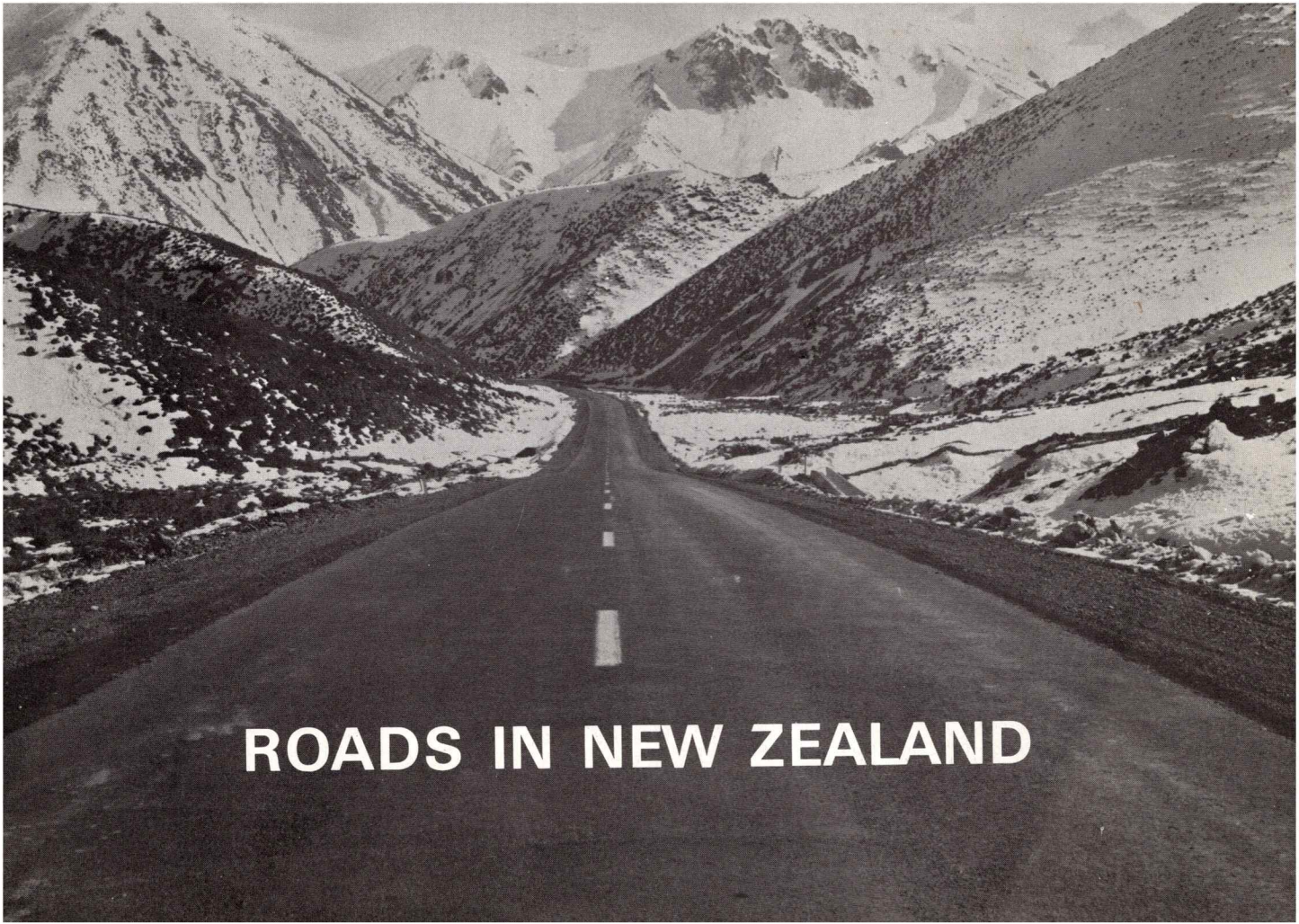
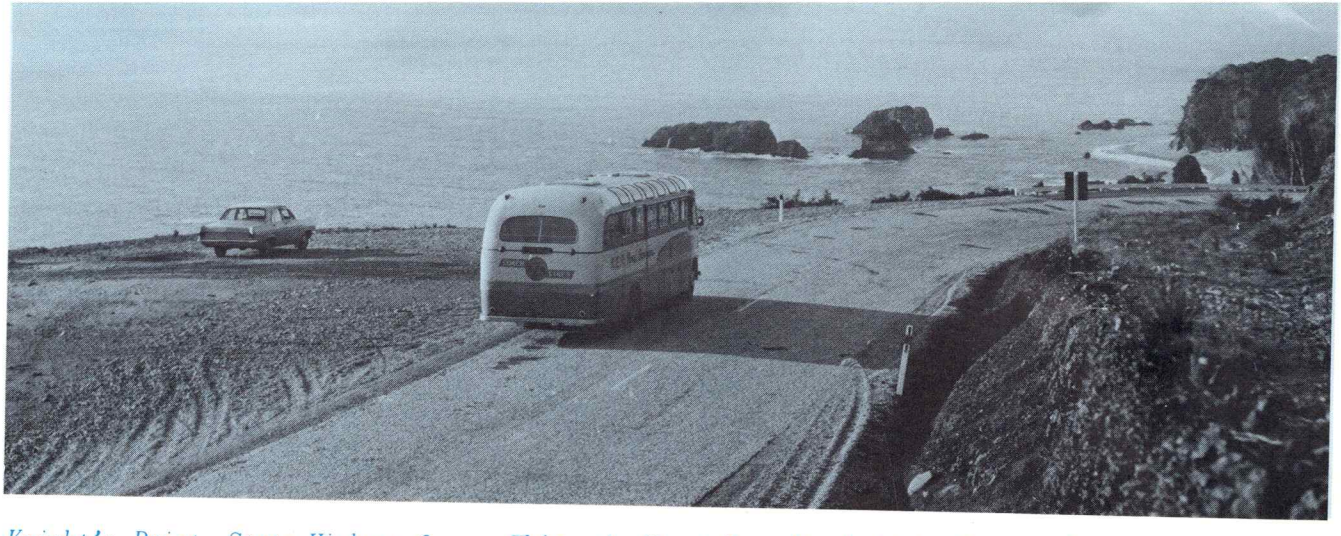

ROADS IN NEW ZEALAND



Knight's Point, State Highway 6. This, the Haast Pass Road, links Otago and the southern part of the South Island with the West Coast. Opened in 1965, the road is still being sealed progressively. Completion will mark the end of a project begun in 1929. Some of New Zealand's most magnificent scenery is found in this area, and construction of the road has been a difficult, expensive task.

COVER –

Porter's Pass, State Highway 73. A main trans-alpine link between the east and west coasts of the South Island, this road follows a historic route. In bygone times a Maori track to the West Coast lay over the pass; in the days of the gold rushes thousands of diggers trudged over it, By 1916 motor traffic was using it regularly. The most recent reconstruction took place in 1966.

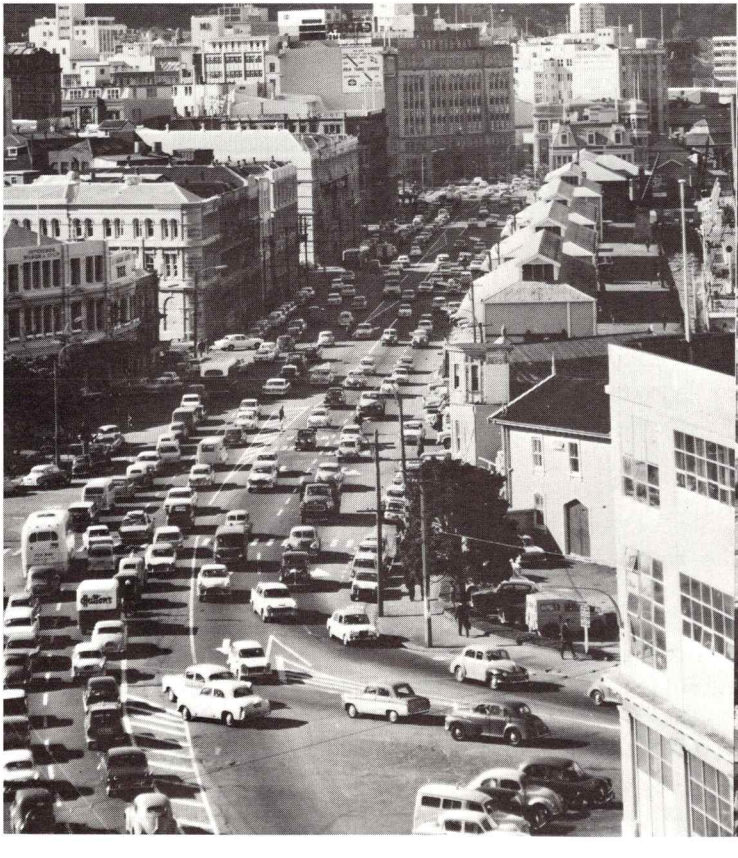
ROADS IN NEW ZEALAND –

It is only 120 years since there were no roads at all in New Zealand, only bush tracks which the Maoris knew and used; pioneers travelled by water or beach paths.

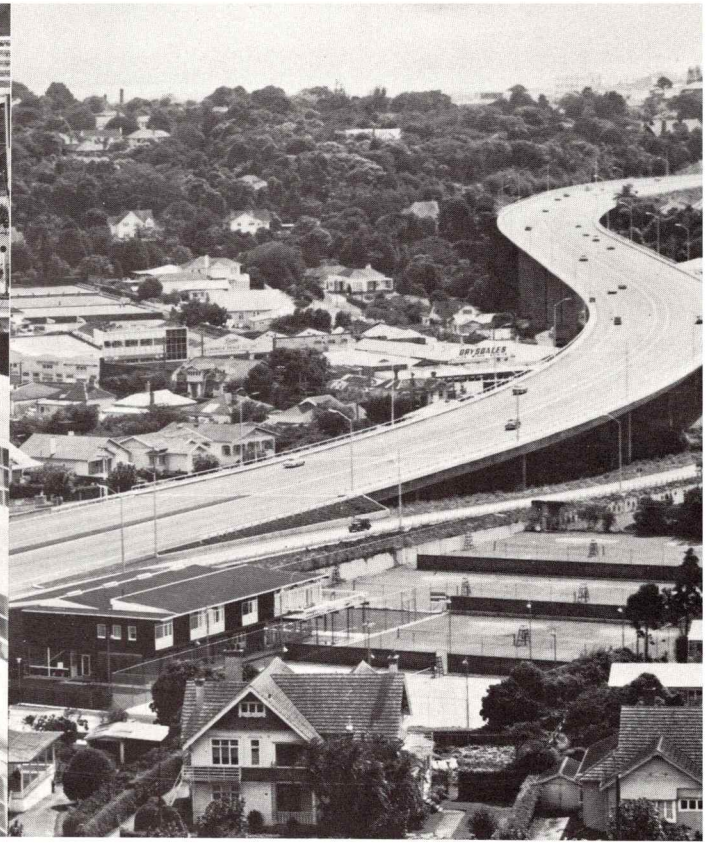
Today there is a network of public roads of 58,000 miles. Although a small population in a mountainous terrain, the nation now has an average density of 0.65 miles of road for every square mile of land. And the population is well served, for there are very few people who cannot drive a small car to within fifty yards of their back door. With 380 vehicles per thousand of population, New Zealand is second only to the United States and Canada in its reliance on the motor vehicle. The rate of increase in traffic on the roads is between five and six per cent annually.

Yet new roads are still required – to open up more farming land, to reach isolated areas for resources development, for example hydropower stations, to reach tourist attractions, to open up land for industry or new housing. In major cities increasingly dense traffic creates new roading demands. In rural areas roads must be modernised and strengthened to cope with increasing traffic and heavier loads.

New Zealand is still a developing country, and development must continue, albeit wise and careful development. This booklet outlines some of the factors to be considered and the work required for one important aspect of the country's development.



Jam-packed streets show a need for new roading facilities.



Traffic flows freely on a new section of urban motorway.

PLANNING AND DESIGN -

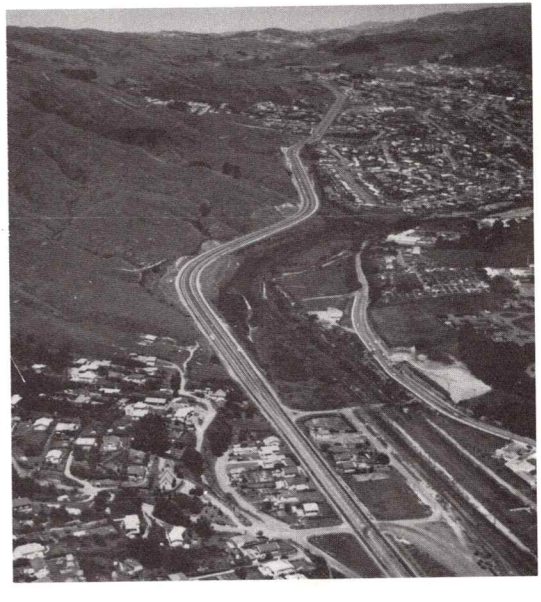
Once the need for a new road has been established, detailed planning begins. This stage is of paramount importance since a mistake may prove not only troublesome and expensive but also irreparable. More time and effort may be spent on planning than on the actual construction of the road.

THE ROUTE -

For a city or suburban road there is often little choice about a route.

For a motorway, a special purpose road often cutting across existing street systems, selection of the route can be tricky. A central city motorway must allow traffic coming into the city each morning to reach parking buildings and key points in the city at speed with a minimum of time and delay. There must be access to the important administrative commercial and business areas of the city. Construction, or demolition of buildings for the motorway must disturb commerce and industry as little as possible.

If possible a suburban motorway system skirts or by-passes major built-up areas as shown at right.

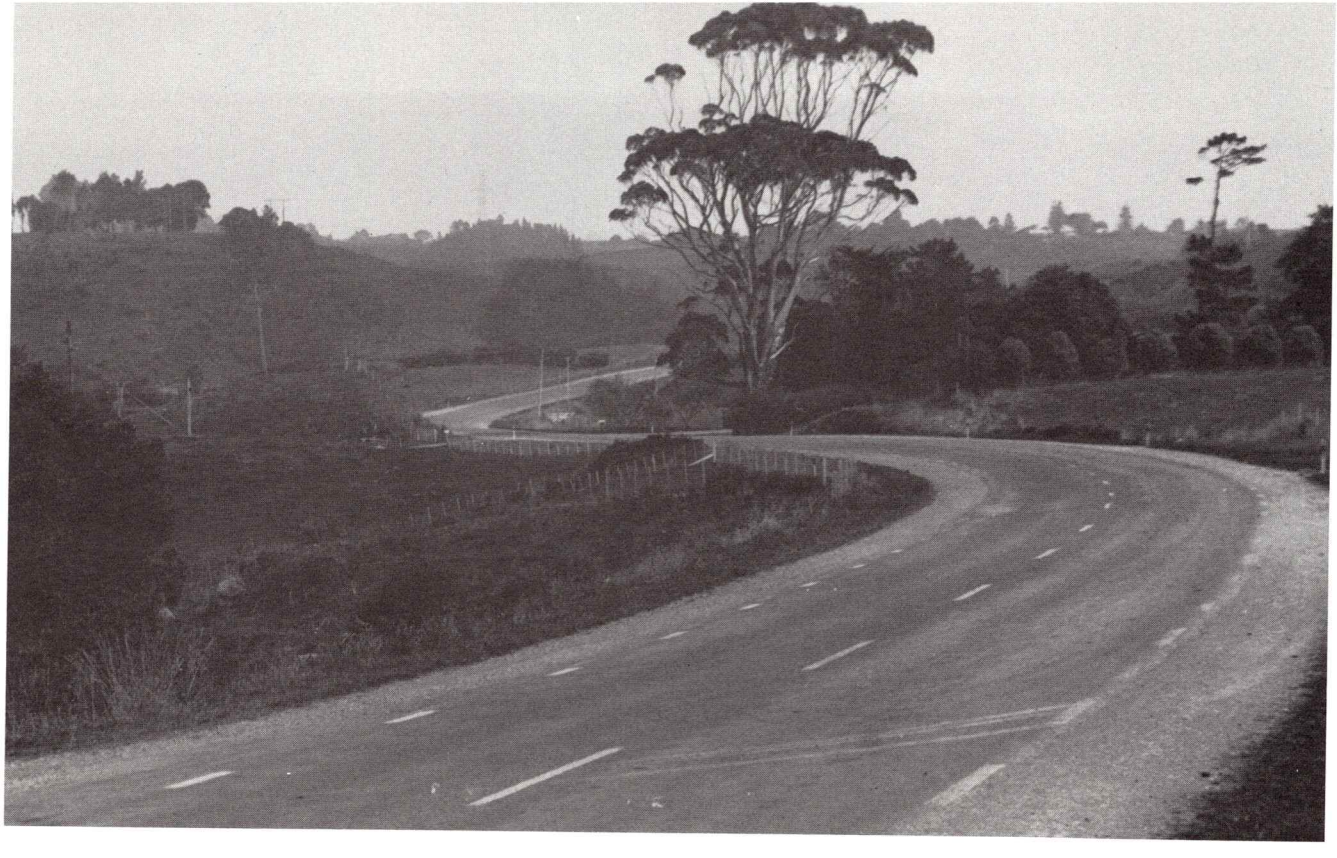


For a road crossing through the countryside careful choice of a route is vital. Topographical maps showing hills, valleys, streams and so on are used first, then aerial photographs for a detailed look at the country. Low lying areas or floodable land must be avoided; valuable natural growth should be preserved, and historic landmarks. A well-planned road follows to some extent the line of the hills, or the slope of the land, and affords interesting or scenic views to prevent monotony and thus promote safer driving. A road should be designed for harmony with the landscape, not to cut through it.

Yet the road must be as direct as possible, free from sharp curves and steep grades, needing as few bridges and culverts as possible. Cost has to be considered; for example, embankments and cuttings which require earthmoving are expensive.

The exact route is finally fixed by ground surveys which provide data on land shape, stream crossings, and the kinds of soils to be dealt with.

Landscaping has been defined as the setting, shaping, planting and maintenance of the highway to redeem the land affected by it. Above, a rest area on the newly constructed Wairakei-Taupo highway adds to the broad sweep of the landscape. As the young trees grow, shaded picnic areas will be available, well away from fast through traffic.



The importance in highway design of a single interesting tree is apparent in this view of curvilinear roading on State Highway 3, a few miles south of New Plymouth.

SOILS AND STRENGTH –

One of the early considerations in planning a road is its purpose, that is the number and type of vehicles which will be using it. City streets carrying a dense flow of slow moving traffic must be stronger than suburban streets with lighter weight vehicles and less traffic. Arterial roads carrying long distance traffic, much of it fast moving or heavily loaded, need a particular standard of strength. There are other roads with special requirements like some local roads carrying vehicles with heavy timber or dairy produce, or roads in areas of the cities near wharves or railway stations where heavy vehicles congregate.

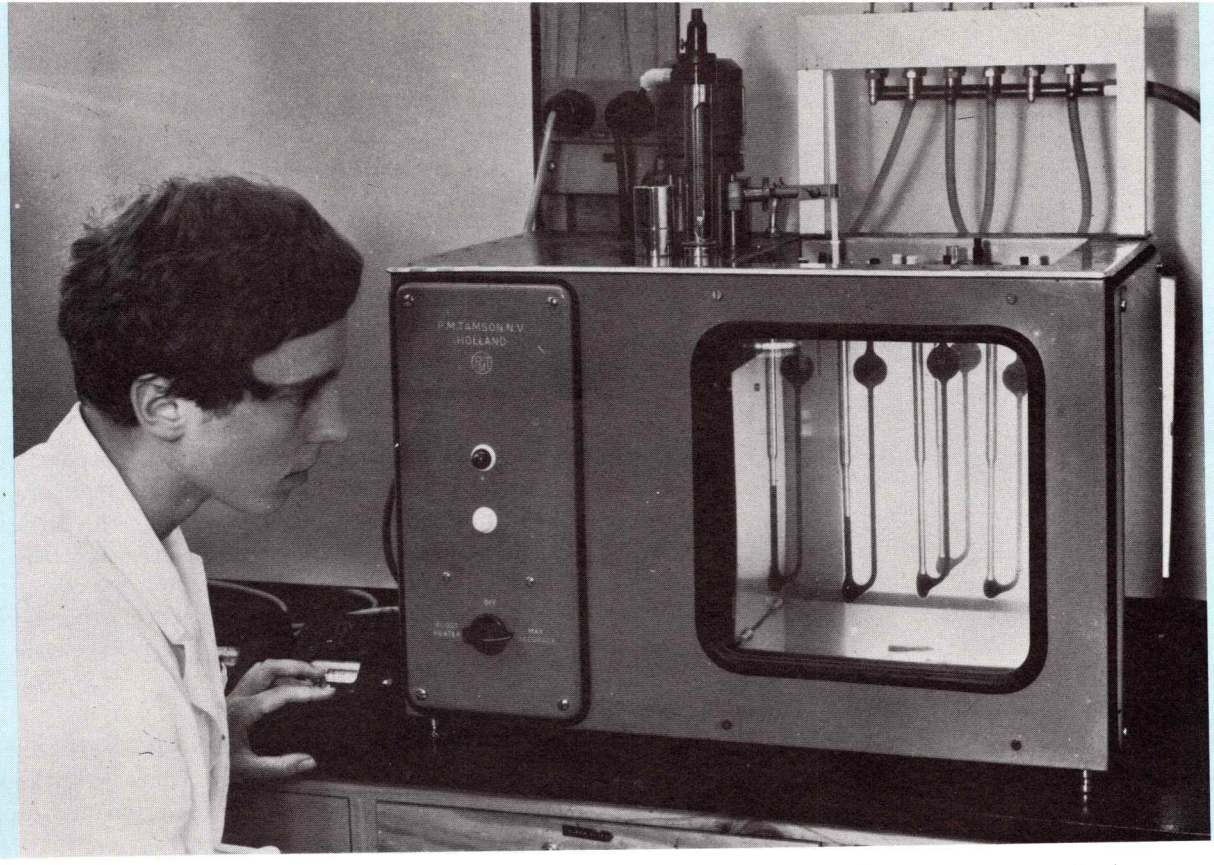
A road consists of the pavement, usually layers of crushed rock with a sealed surface, and the soil foundation beneath, technically known as the 'formation'. The greater the wheel loads, or the weaker the soil of the formation, the greater will be the thickness of crushed rock layers, or the 'basecourse'. In New Zealand the basecourse is usually between six and twenty-four inches thick.

ROLE OF THE LABORATORY -

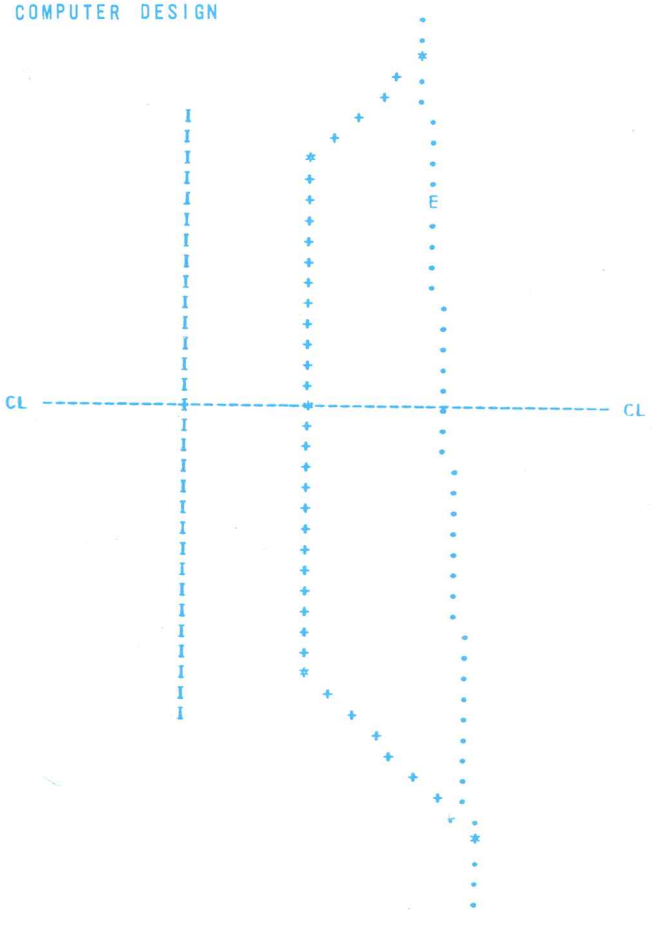
Laboratory tests are required for both the soils of the formation and the materials of the pavement itself in order that the road will meet particular specifications of strength. Local materials are used for the basecourse wherever possible, because transportation from other areas increases the cost of materials. However, some stone breaks down too easily; some is sensitive to moisture and therefore tends to make the pavement unstable. If the underlying formation has too much clay, a filter layer of sand may be needed to prevent it intruding into the basecourse.

Certain areas of New Zealand which are volcanic in origin provide good materials for roading. Other areas such as Hawke's Bay, Canterbury and Southland have excellent 'greywacke' gravels which have been derived from the mountain ranges over a long period of time. But where good quality stone is hard to get or a specially high strength is needed the crushed stone may be improved or kept stable by mixing in portland cement or bitumen. In some areas, pumice or mudstone may be treated in this way.

Although the final decisions on strength and choice of materials and other design factors will rest with the engineer responsible for planning the road, the scientist and his laboratory provide invaluable data for the engineer's decisions.



The apparatus shown above is used to keep bitumen at a steady temperature during tests. One of the fundamental bitumen tests is the measurement of viscosity or liquidness, which varies according to temperature. For example, a thick substance like treacle will become thinner as it is heated.



Computers are now taking much of the fieldwork out of planning new roads, and cutting exploratory work from months to weeks.

When the computer method is used, the area is photographed from the air. The pilot flies a level course, keeping a constant altitude and the camera photographs at frequent intervals.

From the photographs a topographical map is produced with a stereo-plotter. A straight base-line is marked, the middle of the band of country through which the road is likely to run. The stereo-plotter is used to find representative ground-levels on short lines at right angles to the main base-line.

Readings of the ground-levels are fed to the computer with the terrain marked out in numbers representing location and height.

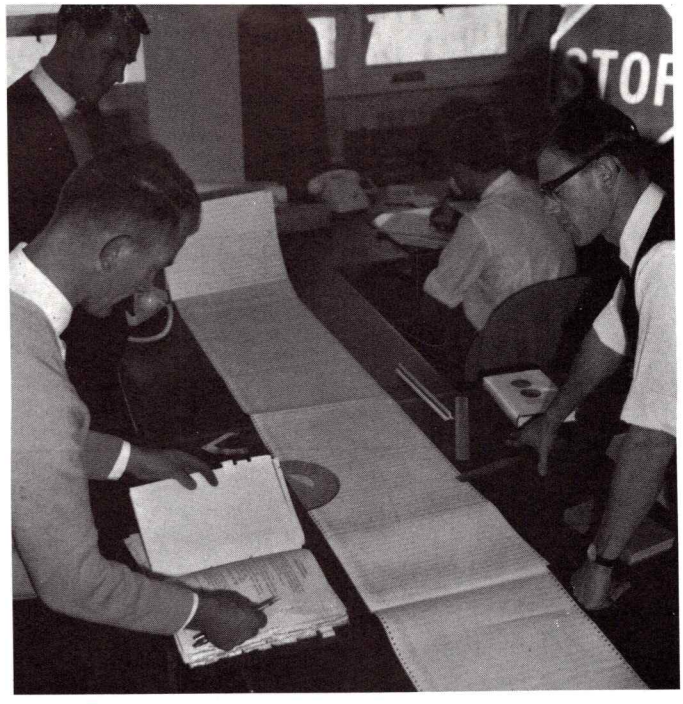
Engineers then use this computer field to try several centre lines for the road before choosing the most suitable. By using a computer many more possible routes can be considered than by using the old system, and the final route may be more economical.

In choosing the best route, engineers bring out a mythical set of vehicles – one large and one small standard truck, and one large and one small standard car. The cost of running these vehicles over all the routes under study is worked out by the computer.

Vehicle-running costs are directly related to the weight of the vehicle, the speed at which it travels, its engine revolutions, its engine power, bore, and stroke, and its transmission ratios.

These factors are also related to certain features of design, for example the number and steepness of hills and gullies, the number of curves, the type of road surface and the restrictions placed upon speed by the law, or by curves and intersections.

When costs are computed, allowances may be made even for delays caused by traffic congestion, traffic lights and accidents.



Engineers study computerised design sheets for a new section of highway.

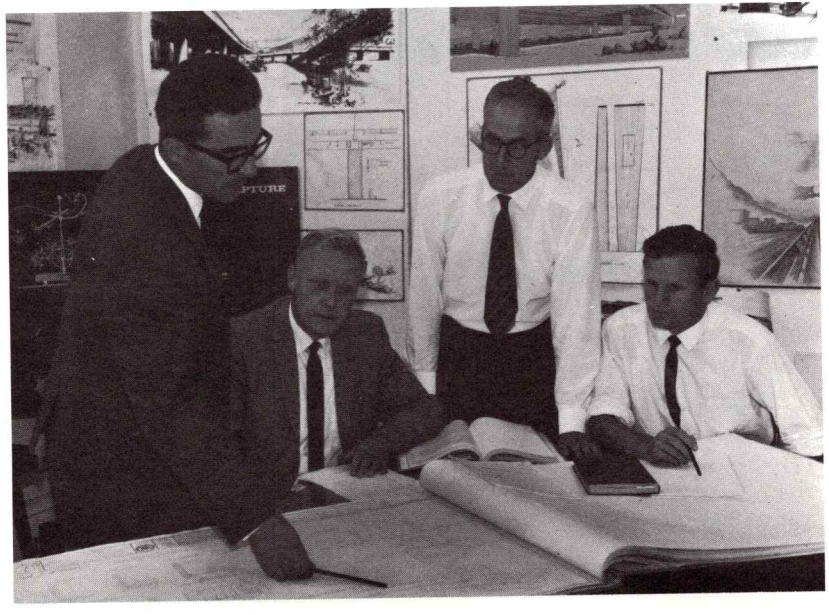
When engineers finally select a centre line for the road, the computer eliminates more arduous field work by supplying the quantities of cut and fill required for earthworks.

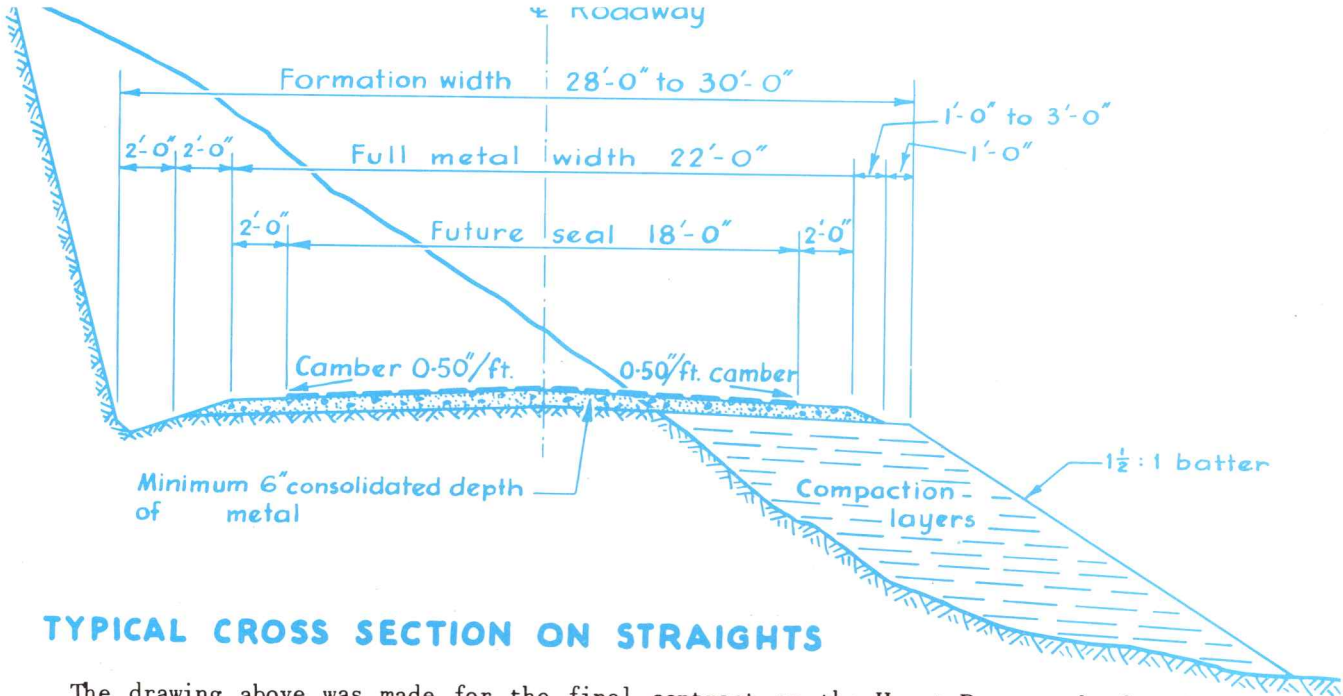
Light cars move out to pass slow moving heavy traffic in crawler lane on the Napier-Taupo road.

THE DRAWINGS -

The final stage in planning is the detailed drawings prepared by draughtsmen and engineers for the contractor who will construct the road. As they are being prepared, the safety aspect and the vehicle speeds must be constantly considered. A third traffic lane, a 'crawler' may be required for steep grades. Curves must be mathematically shaped to allow entry into them at speed, and the 'tilt' of the curve, the superelevation, is also mathematically worked out.

The final drawings will show the road completely laid out on paper with full details of heights of embankments, depths of cuttings, sizes and positions of culverts and bridges, curves, widths, gradients, quantities of earth to be moved, and so on.





TYPICAL CROSS SECTION ON STRAIGHTS

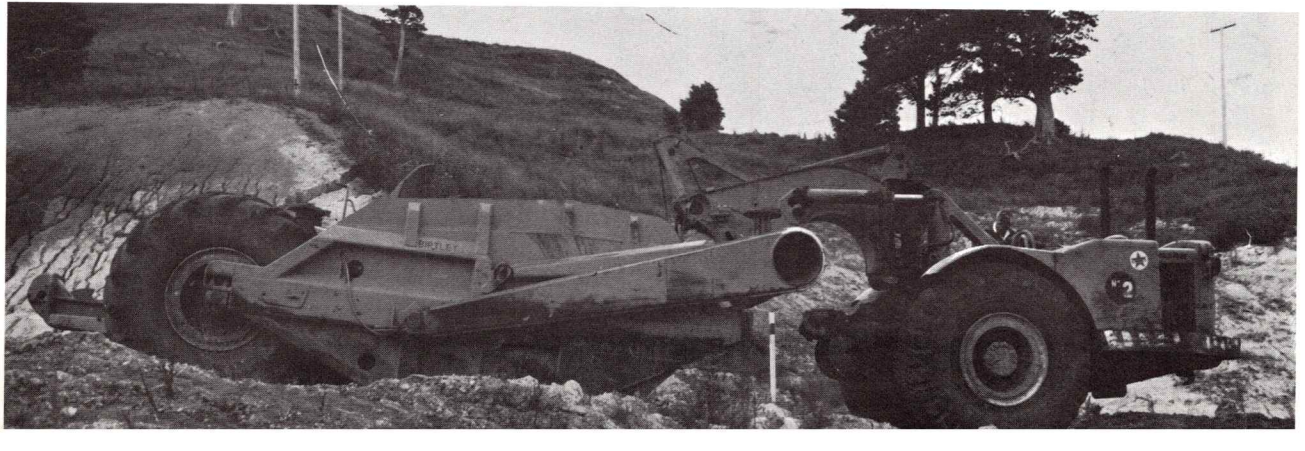
The drawing above was made for the final contract on the Haast Pass road, for the rugged section from Whakapohai River to Breccia Creek. Over this four mile section about 1,000,000 cubic yards of earth had to be moved. This amount would fill the present Parliament Buildings nearly eight times and the new Central Post Office headquarters building in Wellington a little over six times.

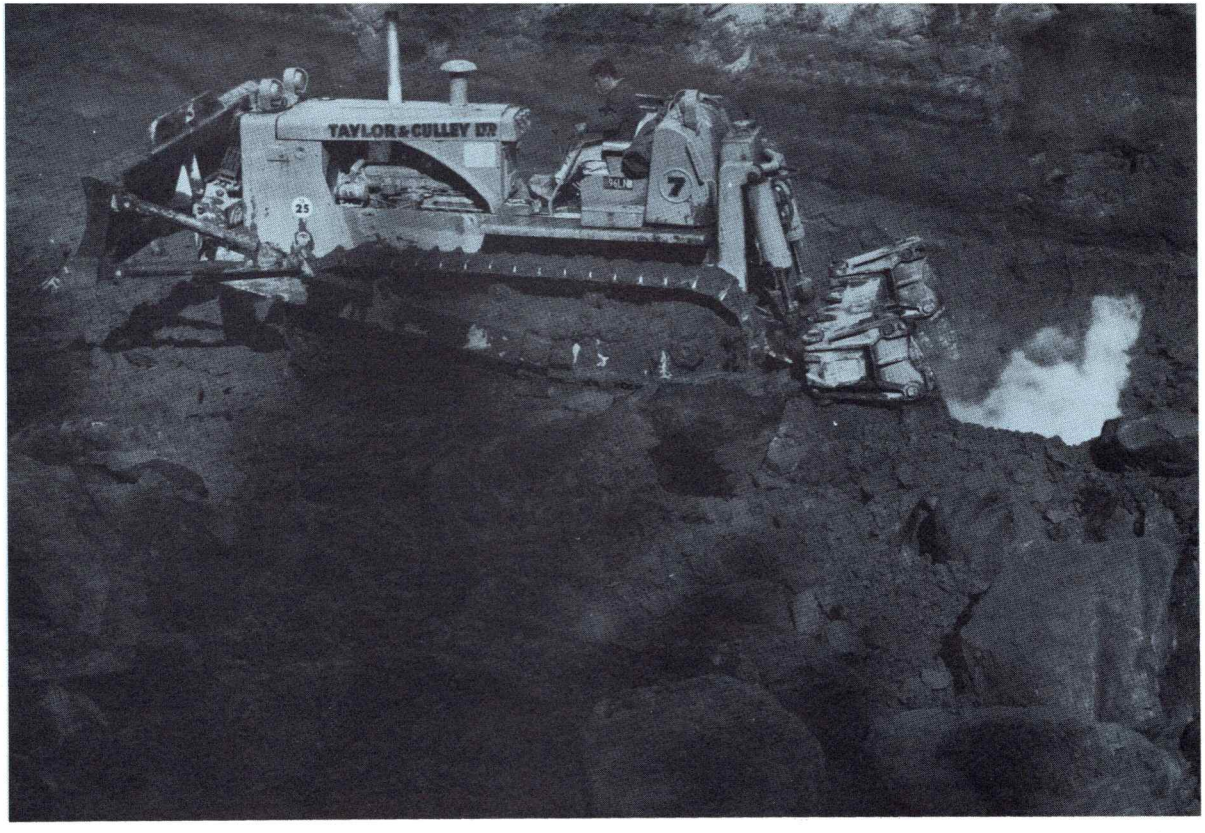
Six major and about 50 minor culverts were constructed along this stretch.

THE FORMATION –

Building the formation is usually the largest job in roadmaking especially in New Zealand where so little of the land is really flat. The bulldozer is useful only if earth is not to be shifted very far; if it has to be shifted more than one hundred yards it is quicker and cheaper to pick it up and carry it.

The machine most often used is the scraper, which is a large bowl supported on rubber tyres pulled either by a crawler or rubber tyred tractor. The bowl is lowered as the machine moves, scraping up a layer of earth. The full bowl is raised, drawn away, and the material pushed out by a moving gate to form a thin layer on the ground where needed. Thus earth or even loosened soft rock can be taken from a cutting to form an embankment further away.

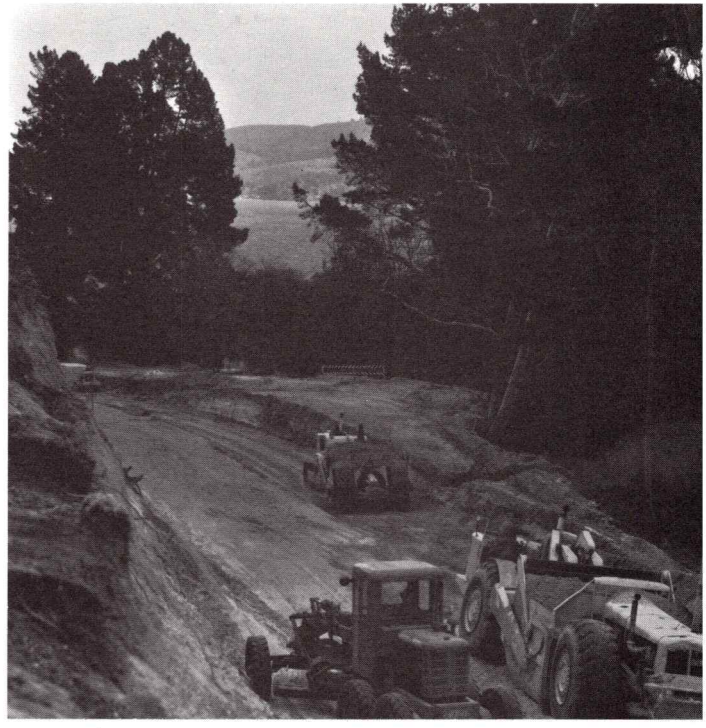




Soft rock or tightly packed earth may need to be broken by a tractor drawn 'ripper' before the scraper can be used. Hard rock may need blasting.

Compaction plant, usually heavy rubber-tyred rollers, is also required to assist the scrapers. Layers of earth placed by the scrapers in an embankment must be pressed into a mass as firm as the engineer has specified.

Finally, the grader is used to clean up the surface, and the side-slopes or 'shoulder' which is designed to support the edge of the pavement, help drainage and provide a safety margin.



State Highway 6 in South Westland has pavement basecourse complete but is not yet sealed with bitumen.

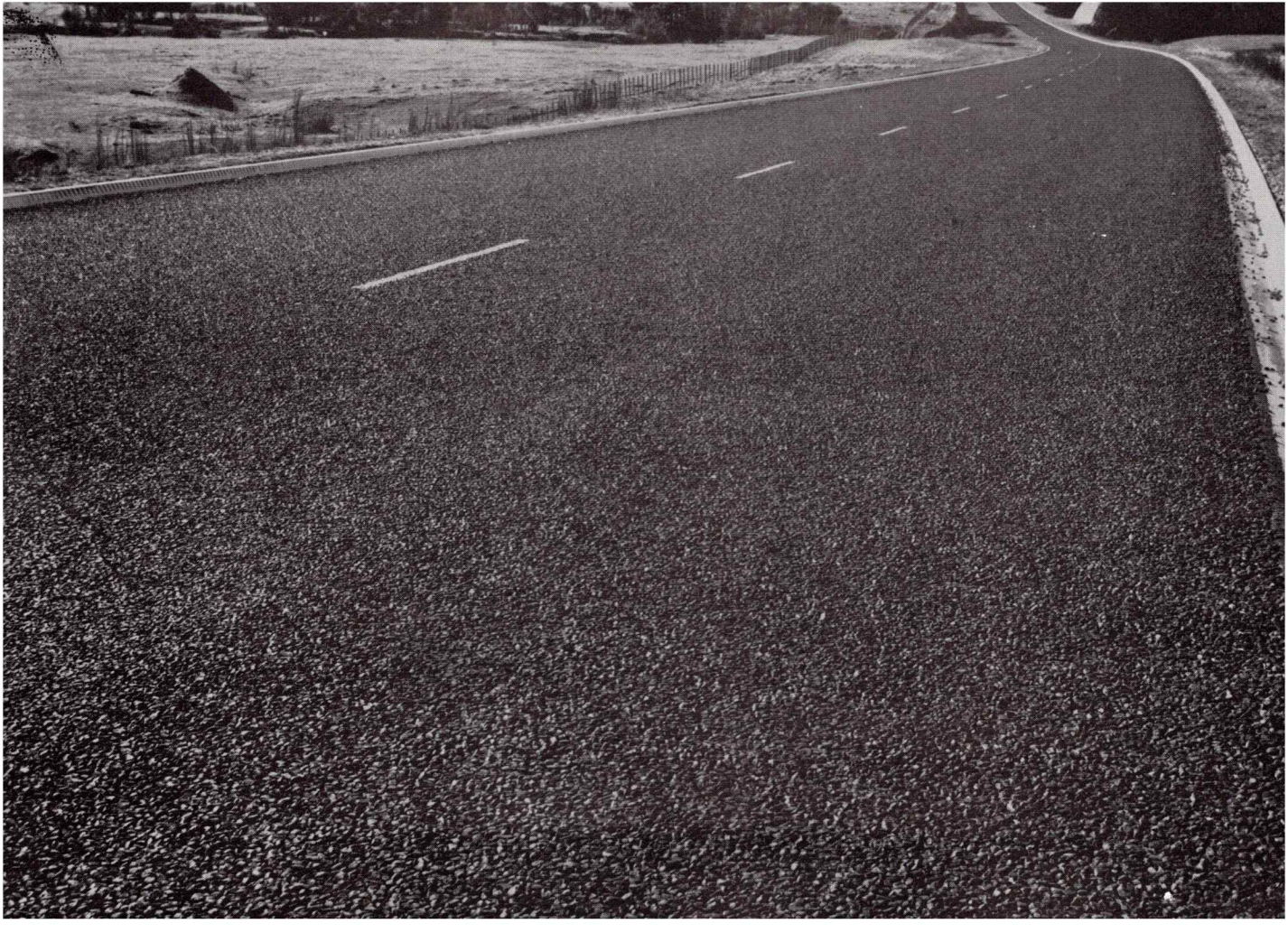
THE PAVEMENT -

Basecourse, like earth for embankment formation, is placed and compacted in layers with the strongest materials near the surface where the highest pressures will be. After spreading, the rock is trimmed by a grader to the right shape and rolled further.

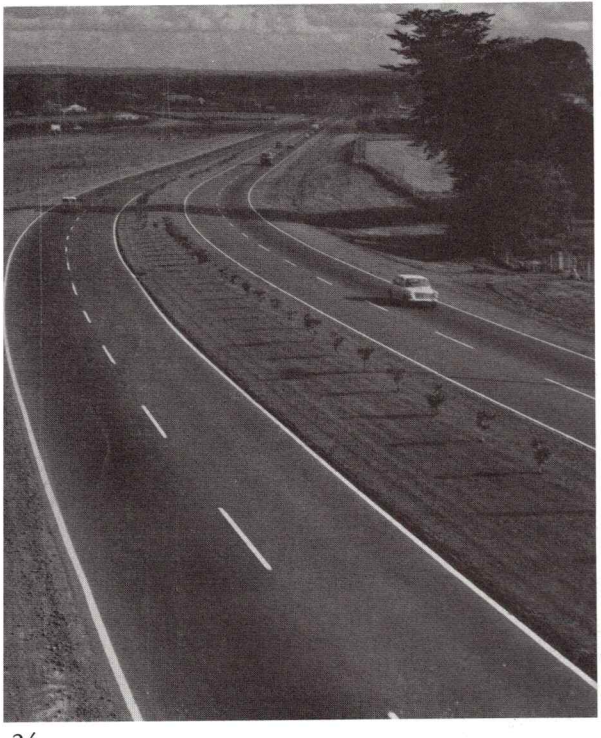
Lastly comes the bitumen seal. Bitumen is not a strong substance by itself; it acts rather like a coat of paint. It protects, waterproofs, and has certain wear-resisting properties. Most road surfaces in New Zealand are chip seals, that is, stone chips are pressed into the bitumen to take the wear and tear of traffic while the bitumen holds them in place.

There are usually two coats of bitumen and chips. The first coat may be coal tar and the chips will be small, about three-eighths of an inch in size. For the second coat and for maintenance coats, bitumen will be used and the chip size may vary between three and five-eighths of an inch.

Bitumen or tar is sprayed onto the road in calculated amounts for a square yard of surface. There must be just enough bitumen to come a little more than half-way up the chips when they are pressed in. With too much, cars are splattered on hot days; with too little, the chips are torn off. Another type of bituminous road surfacing is asphaltic concrete. It has strength as well as sealing properties and is used for a road which must withstand great stresses. Asphaltic concrete here refers to a mix of hot bitumen and stone which sets in much the same way as the usual 'concrete' does. The mix is laid hot, rolled, and sets very hard as it cools.



THE FINAL STAGES -



Work does not end with the road construction itself. No road can be planned to perfection so traffic must be both guided and guarded, by warning signs, speed restrictions, direction signs, posts and fencing. Obstructions need to be highlighted and reflectors strategically placed for night driving.

Pavement markings are widely used in urban areas, and all State Highways require white centre-line markings and yellow no-overtaking lines in certain places.

Rest and picnic areas are provided at suitable spots and lookout points at places of scenic interest.

In forested areas, native ferns and lichens may be encouraged to grow on roadside slopes or 'batters'.

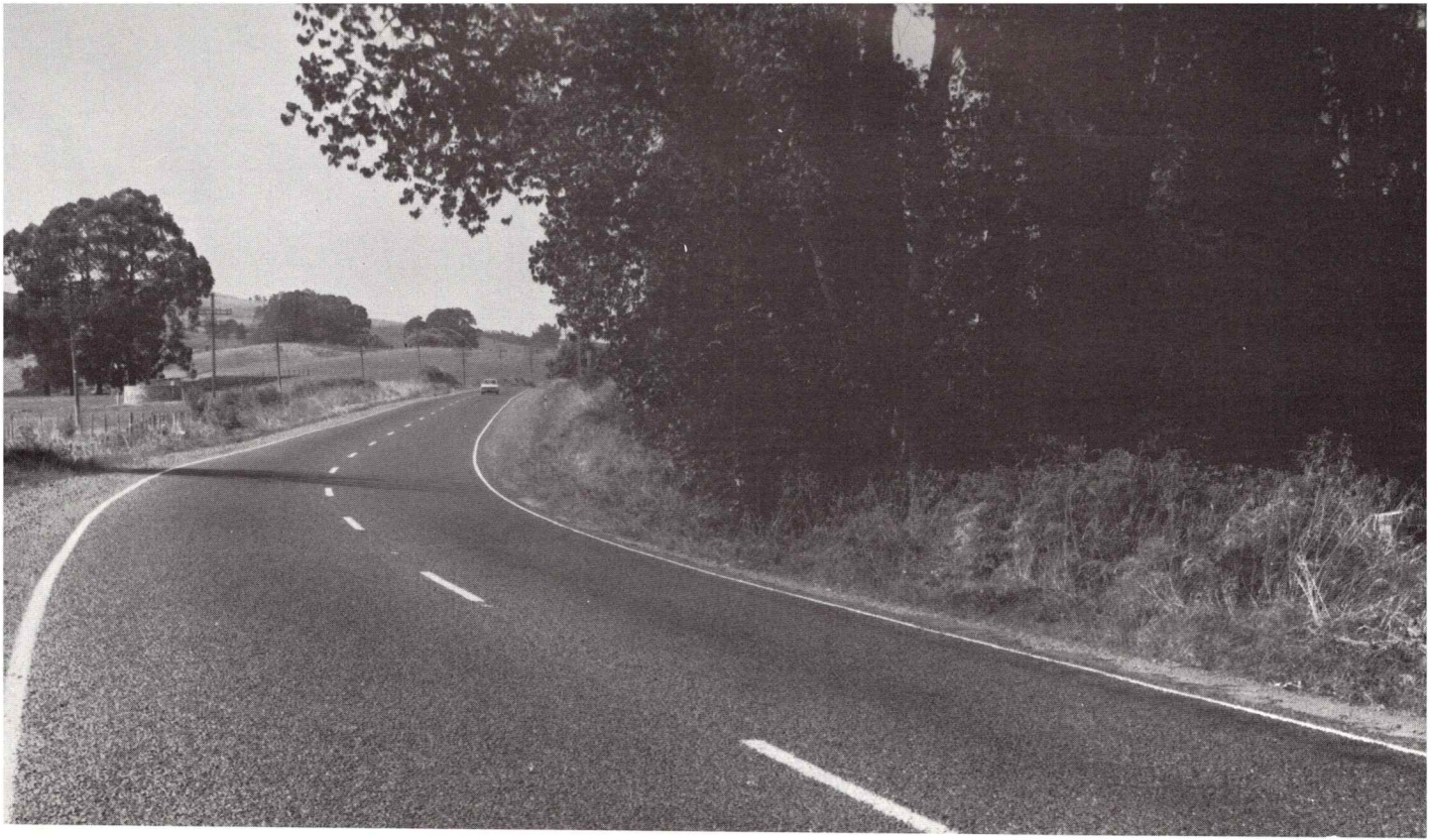
In urban districts different types of roadside plantings may be carried out according to the amount of land available.

A rest area on State Highway 1 near Cambridge provides a shady picnic area beside the Waikato River. It was provided by the Ministry of Works in the course of highway work for the National Roads Board.

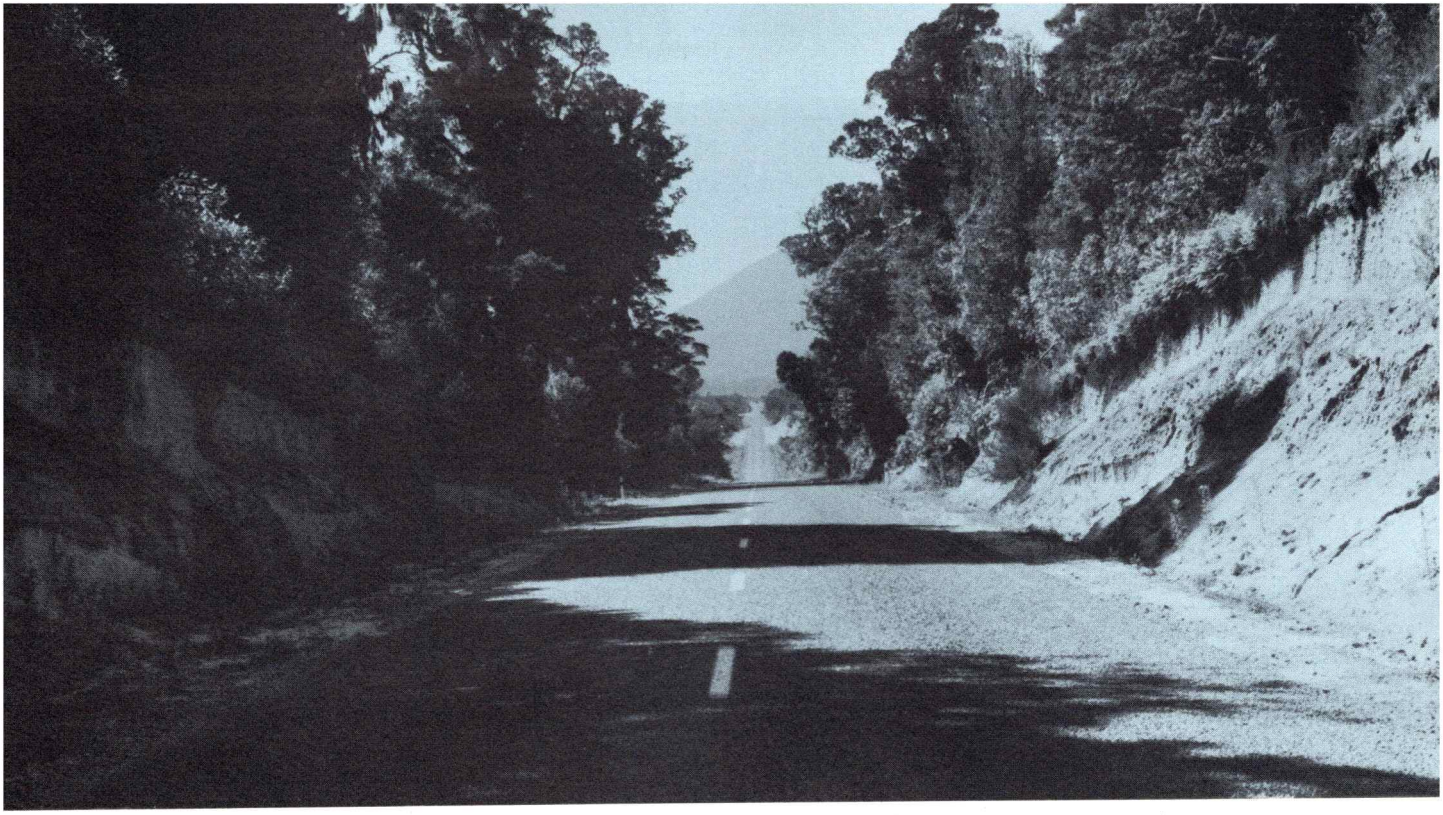
In order to restore construction wounds on the highways, modern erosion control equipment has been imported. The machine shown at left is the Finn Hydroseeder, spraying selected grass seed and fertiliser over parts of the roadside which have been bared of vegetation. By the use of this machine large areas of otherwise inaccessible roadway can be sown and scars soon healed.

Road maintenance begins before construction ends. All roads need regular attention and even in the worst of weather traffic routes must be kept open. Scrub and bushes must be kept back, drains must be kept clear to prevent scour and other damage. Potholes must be repaired as quickly as possible since deterioration can be very rapid.

Maintenance keeps the road in 'as new' condition. It requires a large proportion of annual roading costs, amounting to about a third, in fact. Grass mowing costs alone range from $30-$200 per mile per year; reseals, required to keep the roads skid free, can cost up to $2 million per year.



State Highway 1 near Cambridge was designed to provide pleasant driving through a rural landscape.



Patterns of light and shadow enliven a long straight stretch of State Highway 5, near Taupo, where the route passes through stands of native bush. Roadsides have been shaped and treated to allow natural regrowth.

RESEARCH AND THE FUTURE -

New Zealand has been in the forefront of developing low cost road construction using the two-coat seal surface. Up to now this has served the country well and will continue to do so on the more lightly trafficked roads.

It is now becoming important to develop the techniques needed to build roads to serve very heavy traffic loadings. Techniques must be developed to predict just what loadings will occur on particular roads.

The National Roads Board, with the Road Research Unit and the Signs Committee is studying this problem among others. Dynamic weighbridge equipment has been installed at a site on State Highway 1. Trials have indicated that vehicles make a higher impact on a road than has been realised. Pavement studies have included the behaviour of hot laid asphaltic surfaces, and effective road markings for motorways.

Supported by two-year research grants, University Schools of Engineering are investigating characteristics of bridge piers, and the behaviour of embankments and foundation soils with reference to bridge structures under earthquake conditions.

Studies made in the economics field include vehicle operating costs and the relationship between road transport and the total cost of production. In another project the New Zealand Institute for Economic Research is determining total commodity flows and predicting heavy haulage patterns for 1972-73.

Expenditure by the National Roads Board on research projects was over $63,000 for 1969. The results will help engineers and planners to select the best alternatives for road construction. The benefits of high class roads extend further than reductions in operating costs, accidents and time. The whole national economy benefits.

Even although heavy expenditure in the last 20 years has literally transformed the country's roads, the long-term national goal remains that of a roading system equal to the highest world standard.

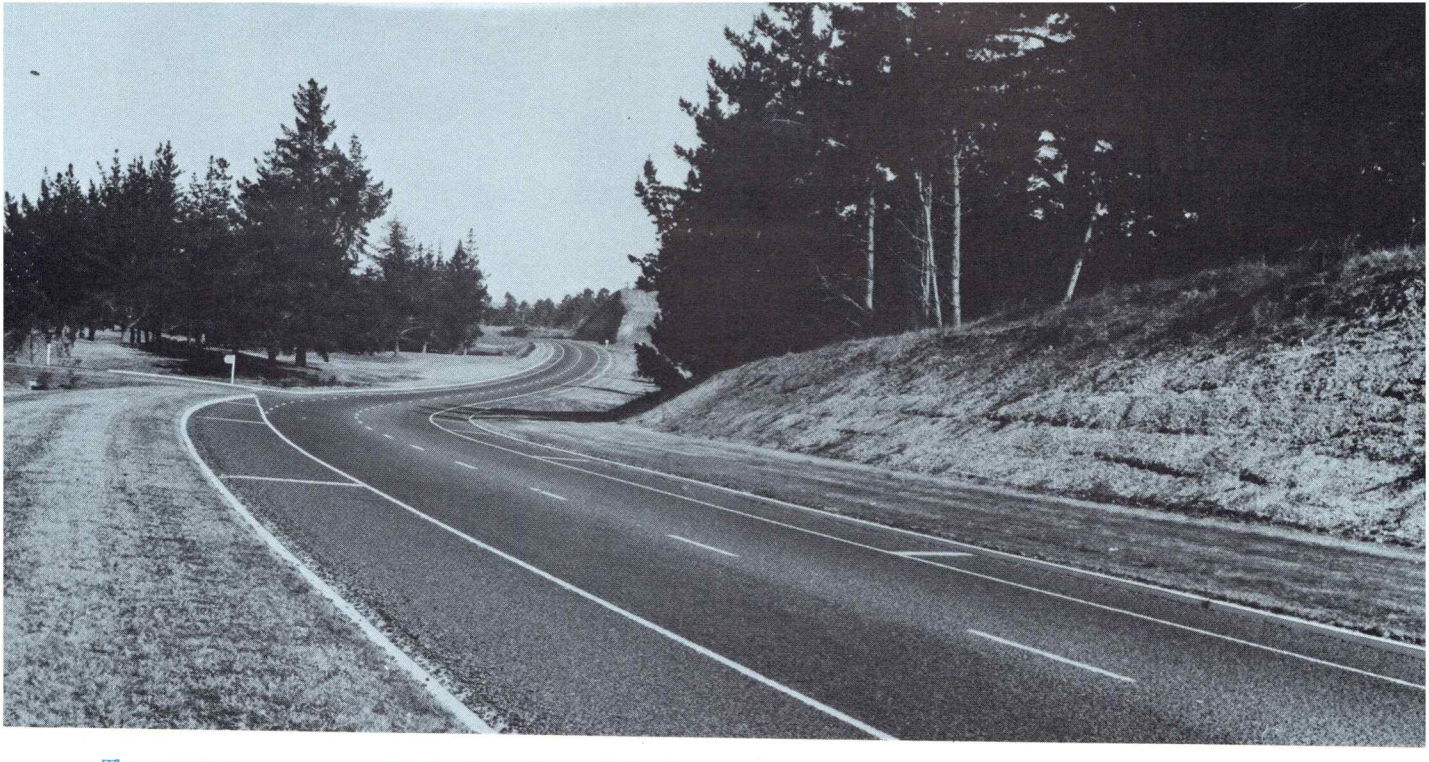
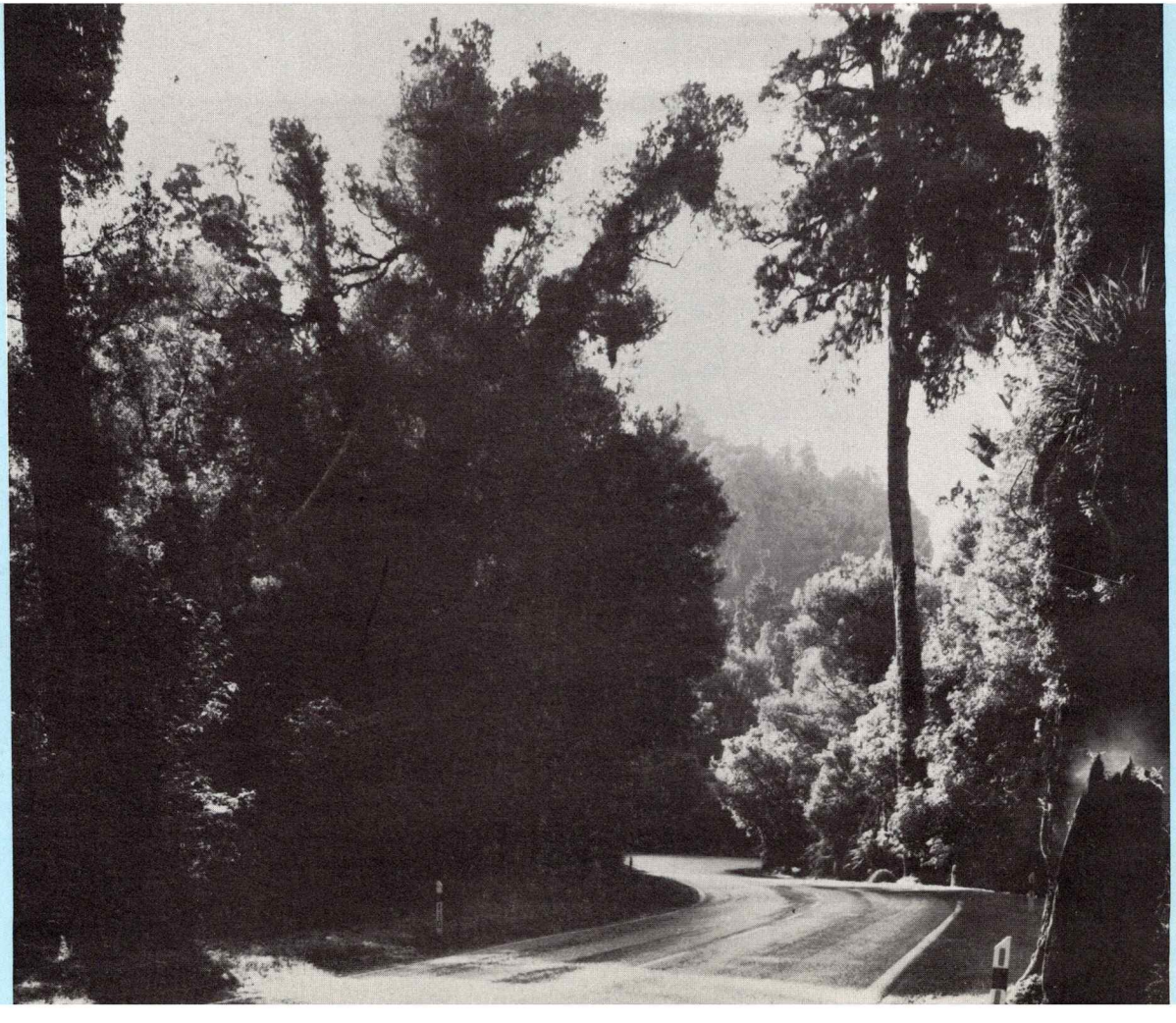
BACK COVER -

Hongi's Track, State Highway 30. Hongi, a well-known Maori chief, led a war party in 1823 against the Arawa tribe of Rotorua. State Highway 30 follows part of the route he took when dragging canoes from lake to lake.

Grassed batters, well recovered from construction, allow light, air and better visibility while enhancing the beauty of the native bush.

ISSUED BY THE NATIONAL ROADS BOARD, P.O. BOX 12041, WELLINGTON NORTH

INFORMATION LEAFLET NUMBER 2, JULY 1970



The most important single benefit of landscaping is road safety. In New Zealand the challenge of landscaping is to preserve and also exploit a richly varied landscape. The Wairakei-Taupo highway, State Highway 5, reconstructed in 1968 reveals the natural landscape delightfully. Above, a large batter and pine covered ridge gives strength and provides the motorist with a distinct consciousness of passing from one area to another